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*The Silurian Rocks of Melbourne and Lilydale: A Discussion of the Melbournian-Yeringian Boundary and Associated Problems.*

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## Silurian Type Areas.

In 1903 Professor Gregory (7) divided the Silurian rocks of Victoria into two series, namely:

2. Yeringian (Younger).
1. Melbournian (Older).

In 1933 Thomas and Keble (17) introduced a third and older division, and the succession now generally recognized (4) is:

3. Yeringian.
2. Melbournian.
1. Keilorian.

The Keilorian is typically developed near Keilor, north-west of Melbourne. These rocks were included by Gregory in the Melbournian. Melbourne is the type area for the Melbournian. Gregory specially mentioned the fossil localities at Moonee Ponds Creek and South Yarra (Improvement Works). I propose that, by reason of priority of systematic description in McCoy's "Prodromus" (12) and other publications, the Moonee Ponds Creek locality be regarded as the Melbournian Type Area, in the restricted sense. Such a distinction is needed as a basis for the further subdivision which the Melbournian requires.

In dealing with the Yeringian rocks, the beds are still called "Silurian" (although Ripper (16) and Hill (8) have recently suggested a Devonian age for the Cave Hill limestone), the reason being that this paper is concerned with the succession of the strata and not a discussion of their age.

The Lilydale district is the type area for the Yeringian. This area comprises the following original fossil localities:

- (a) Cave Hill (bluish limestone).
- (b) Wilson's (fawn shale).
- (c) Hughes's Quarry (chiefly fawn sandstones).
- (d) "Yering, near Coldstream" (yellow and purplish shales).
- (e) Hull Road (reddish and occasionally white shales).

This number of localities has been greatly multiplied by recent investigations. The question of a restricted type locality is a difficult one because the limestones and shale faunules are almost mutually exclusive. I propose therefore that two restricted type localities be recognized, one for the limestones and one for the shales. Further, that these be Cave Hill and Hull Road respectively. Hull Road is the nearest of the original localities to Cave Hill, being separated from it by only 275 yards. A detailed survey of the area has shown that the two series of strata are conformable, there being regular easterly dips in between.

### The Melbournian—Yeringian Boundary.

A problem awaiting solution is the precise location of the boundary between the Melbournian series and the Yeringian series. The chief difficulty lies in the fact that so many of the strata between Melbourne and Lilydale have so far yielded no fossils. The occasional discovery of new fossil localities, however, gives some hope of the needed palaeontological data being forthcoming even yet.

At Croydon there is a prominent scarp running north to the River Yarra. Jutson (10) described this as a fault scarp. It has generally been considered that in all probability this is the boundary between the Melbournian and Yeringian, the latter being faulted down against the former. Hills (9) on physiographic grounds denied the presence of this fault. The author, after a fairly detailed examination of the area, has reached the same conclusion. During the examination of the area under discussion, Yeringian fossils were found west of the so-called fault-line, proving that whether there be a fault there or not, it is not the boundary between the Melbournian and the Yeringian. These fossils were found on Yarra Road, which proceeds north to Wonga Park, at a location on the west side of the road in a cutting immediately south of Bryson Road (Military Map reference 298, 444). They were found in a whitish quartzitic sandstone having light touches of red ferruginous stain. The rock is often considerably pitted on the bedding planes. This is due, apparently, to the leaching away of calcareous organic fragments. The determining fossils are:

*Phacops fecundus* McCoy non Barrande.

*Anoplia*, sp. nov.

The first fossil is sometimes confused with *Phacops sweeti* Eth. fil. and Mitch. (6). It is common in the beds underlying the edge of the Older Basalt on the western side of Lilydale (i.e. Melbourne Hill, Lilydale), and has been collected from Rud-dock's Quarry. The second fossil is a smooth Chonetoid brachiopod (described in MS) which is common in the Yeringian strata

and particularly so at Ruddock's Quarry. The genus is new to Australia and is found in the Yeringian of the Kinglake District as well as at Lilydale.

It is relevant to record also three new fossil localities which help to link up the Yarra Road locality with the well-known Lilydale localities. Fossils of Yeringian affinities have been collected from:

(1) The corner of the Melbourne-Lilydale highway and Edward Road, called "The Black Springs". The strata from which the fossils were collected outcrop in the gutter on the north side of the main road, under the edge of the Older Basalt residual. The following were obtained at this point:

(a) In fawn shale—

*Anoplia*, sp. nov.

*Atrypa reticularis* (Linnaeus).

*Bellerophon* sp.

*Leiopteria* sp. (found also at Ruddock's Quarry).

*Orthonota* sp.

(b) In micaceous sandstone—

*Lingula* sp. (same form as from Hull Road, Lilydale).

cf. *Loxonema* sp.

Fronced crinoid stem (similar to one collected from Ruddock's Quarry).

I suggest that this locality be known as "Black Springs". It is so marked on the Military Map. Definite locality names are being suggested in order to prevent the use of a number of names for the same place. This has happened in the past and caused confusion. The localities are also shown on the map which accompanies this paper (fig. 1).

(2) The second new fossil locality is in a cutting on Manchester Road at the top of a hill 500 yards south of the Black Springs corner. Among the fossils from the greyish-brown shale of this site are:

*Anoplia*, sp. nov.

*Nucleospira australis* McCoy.

*Orthoceras* sp.

I suggest that this locality be known as "Manchester Road".

(3) The third new locality is in a cutting on the main Melbourne-Lilydale highway between North Croydon and Black Springs. The cutting is  $\frac{3}{4}$  mile east of Brushy Creek, on the north side of the road. This collecting place yielded:

*Chonetes bipartita* Chapman.

*Dalmanella elegantula* (Dalman).

*Phacops* (*Acastina*), sp. nov. (?)

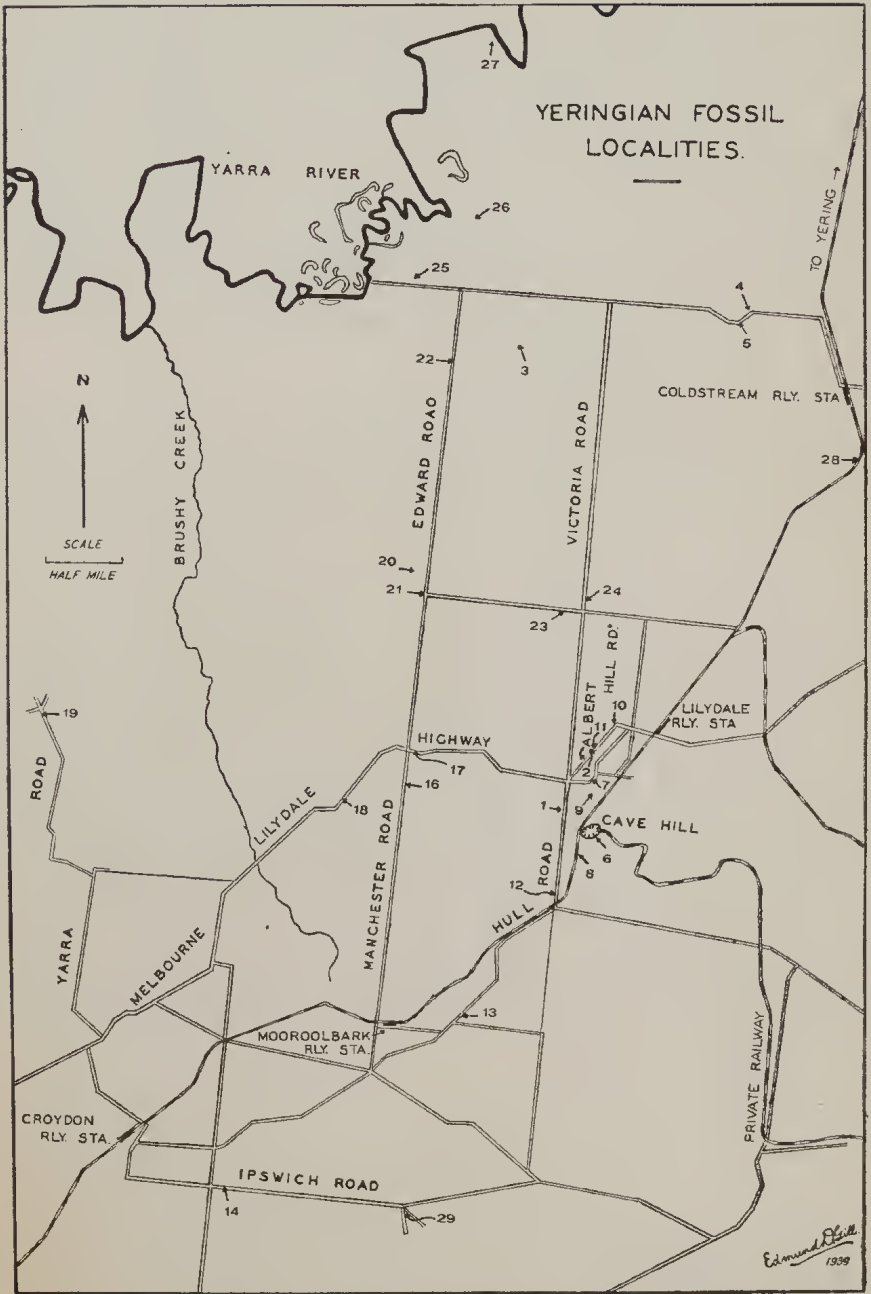


FIG. 1.—Map of Lilydale-Croydon Area showing Yeringian Fossil Localities.

*Acastina* Reed (15) is a sub-genus of trilobite not recorded from Australia before. A good specimen has been found among the fossils collected from the Lilydale shales by the late Rev. A. W. Cresswell. This is apparently the specimen recorded previously as *Dalmanites* sp. (3, and repeated in 6). The *Chonetes* is a typically Yeringian fossil. Besides the fossils listed above there was collected a series of circular and polygonal crinoid stem joints which constitute a typical Yeringian assemblage. Crinoid fragments are useful in stratigraphic correlations as Moore (13) has shown.

The fossils from the above locality were collected from hard, red shales, except for some of the crinoid stem joints which came from a micaceous sandstone. I suggest that this locality be named "West of Black Springs".

The three new fossil localities described occur between the Yarra Road locality and the well-known Lilydale localities. In 1911 Jutson (11) published a paper on the Warrandyte Goldfield in which he wrote "South-east from Warrandyte, the beds should become younger, until the youngest of the area would occur a little to the north of Croydon". This inference is now supported by the collection of Yeringian fossils on Yarra Road.

In 1855 Blandowski (1) recorded fossils from "Anderson's Creek, about a mile from the junction of that stream with the Yarra Yarra". He described two fossils but figured a number of others without naming them. Blandowski did not indicate what magnifications he used in figuring the fossils, but apparently they are all microfossils, for he writes, "The multitudes of very minute fossil remains . . . with a few exceptions, can be detected only by the aid of a powerful glass," and "I have discovered by a minute examination . . . the forms exhibited in the plate." A search was made recently for the stratum to which Blandowski referred. Similar rock with microfossils was found in the area described, and may be that to which Blandowski refers. However, no extensive collecting has been done yet. As far as present knowledge goes, the fauna of these beds is without stratigraphical significance. The forms are not known elsewhere in the Melbournian or Yeringian.

From grits in Anderson's Creek (precise localities not given) collected by Jutson (11) and the Geological Survey, there are specimens of a *Spirifer* having some affinities with *S. lilydalensis* Chapman.

Chapman (3) in his list of Silurian fossils records as part of the Melbournian series the following fossils from "Anderson's Creek" which were collected from fine-grained, grey shales by the Geological Survey:

- Cyrtolites* sp.
- Holopea wellingtonensis* Eth. fil.
- Orthoceras* sp.
- Palaconilo victoriae* Chapman.



This faunal assemblage was no doubt considered to be Melbournian largely because of the presence of *Palaeoneilo victoriae* which has been recorded hitherto only from the Melbournian series (vide 3, p. 208). However, typical specimens have been found at Hull Road, Lilydale and Ruddock's Quarry. *Palaeoneilo* cf. *victoriae* has been collected from the Yeringian of the Kinglake district by Mr. R. B. Withers. Also, it has been recorded from Fraser's Creek and Broadhurst's Creek, both of which localities the author regards as Yeringian. The trilobite constituents of both these localities are definitely Yeringian. *Chonetes melbournensis* has been recorded from Broadhurst's Creek (3) but the specimen is not referable to that species. All the fossils from both localities are either exclusively Yeringian or common to both the Melbournian and Yeringian.

*Holopea wellingtonensis*, the other specific determination from "Anderson's Creek" is not found in any definitely Melbournian locality, but is recorded from Broadhurst's Creek. The species was described originally from Wellington Caves, N.S.W.

So it appears that the fossil assemblage from "Anderson's Creek" is quite indecisive. Further, the assemblage cannot be used as a stratigraphic guide because of uncertainty as to its origin. Although the fossils are marked "Anderson's Creek" they also bear the Geological Survey locality mark "B 22" which is "Watson's Creek, 2 miles below Wilson's Station". Because of the uncertainty of its location and the indecisiveness of its character, the fauna of the "Anderson's Creek" locality is of little value for the present purpose.

It has been noted that the most westerly Yeringian locality from Lilydale is Yarra Road. The most easterly Melbournian locality from Melbourne is that recorded by Chapman (3) as "Balwyn, near Templestowe" (note typographical error in punctuation). This locality, Mr. Chapman informs me, is a road cutting on the Bulleen Road on the north bank of the Koonung Koonung Creek. From this locality Mr. Chapman collected in 1905 the characteristic Melbournian fossil *Chonetes melbournensis*. Structurally, this locality is on the western limb of the Templestowe anticline.

There, unfortunately, the problem of the Melbournian-Yeringian boundary rests at present. The purpose of this paper is to bring the discussion up-to-date and to arouse interest in the problem. The area between Templestowe and Yarra Road is being searched for fossils, and the structure carefully mapped.

### **The Extension along Strike of the Type Yeringian Beds.**

An accompanying problem to that of the westerly extension of the Yeringian beds, is the extent of their occurrence on the strike-line north and south of the type area. The average strike of the beds is about North 20 degrees East. It has often been

commented that the strata at Lilydale are very fossiliferous, yet north and south of that area the rocks seemed to be devoid of organic remains. A recent survey has revealed the presence of typical, and in some cases plentiful, Yeringian fossils along the strike both north and south of the familiar Lilydale beds.

A. NORTH OF THE LILYDALE AREA.

(1) In a road cutting (marked on the Military Map) at the top of a high hill in Edward Road nearly  $1\frac{1}{2}$  miles north of Ruddock's Quarry, the following have been collected:

*Chonetes*, sp. nov. (a form very common at Ruddock's Quarry).

*Palaeonchilo* sp.

*Platyceras* sp.

I suggest that this locality be termed "Edward Road Hill". This, as well as some of the other new localities, has been only cursorily examined so far, and may yield a fuller assemblage of fossils when more thoroughly investigated.

(2) In the property called "Devon Park" at the northern extremity of Edward Road, two fossiliferous localities have been found on the slopes which are part of the ancient south bank of the River Yarra. The first is at a small cut in the hillside on a track running west from the homestead to the River Yarra. The matrix is of grey shales such as are found at Ruddock's Quarry. A brief examination of the beds yielded:

*Chonetes*, sp. nov. (the form common at Ruddock's Quarry).

*Orthoceras* sp.

*Phacops* sp.

I suggest that this locality be known as "'Devon Park' West".

(3) The second locality in "Devon Park" is half a mile north of the terminus of Edward Road and almost in line with it, i.e. between the homestead and the downstream end of the Yering Gorge. From this place there have been obtained:

*Anoplia*, sp. nov.

*Atrypa reticularis* (Linnaeus).

*Chonetes bipartita* Chapman.

*Dalmanella elegantula* (Dalman).

*D. testudinaria* (Dalman).

*Leptaena rhomboidalis* (Wilckens).

*Orbiculoidea* cf. *selwyni* Chapman.

*Rhynchotreta* sp.

*Spirifer* sp.

*Stropheodonta alata* Chapman.

*Strophonella euglyphoides* Chapman.

*Palaeonchilo* sp.

*Beyrichia* sp.

*Lindstroemia yeringae* Chapman.

I suggest that this locality be known as "'Devon Park' North".

(4) A solitary fossil was clipped out of grey shales at the upstream end of the Yering Gorge, viz. *Chonetes bipartita* Chapman—a characteristically Yeringian form.

#### B. SOUTH OF THE LILYDALE AREA.

Apart from new fossil localities near Lilydale itself the following new collecting places are to be noted to the south:

(1) On Hull Road just north of where it passes under the Mooroolbark-Lilydale railway line, on the west side of the road in the gutter were found:

*Strophonella euglyphoides* Chapman (a typical Yeringian fossil).

*Orthis* sp.

I suggest that this locality be known as "Hull Road Railway Bridge".

(2) At Mooroolbark, on Hull Road, a mile south of the last-mentioned locality, in a cutting on the east side of the road north of the turn-off to Mooroolbark railway station (Military Map reference 347, 403), a particularly rich fossiliferous Yeringian series has been discovered. From these brownish shales the following forms have been recognized:

*Anoplia*, sp. nov.

*Atrypa reticularis* (Linnaeus).

*Beyrichia* sp.

*Camarotocchia* sp.

*Chonetes* aff. *cresewelli* Chapman.

*C. robusta* Chapman.

*Conularia sowerbyi* DeFrance.

*Cypricardinia* aff. *contexta* Barrande.

*Dalmanella elegantula* (Dalman).

*Fenestella margaritifera* Chapman.

*Goldius* cf. *enormis* (Eth. fil.).

*Goniophora australis* Chapman.

*Leptaena rhomboidalis* (Wilckens).

*Lindstroemia ampla* Chapman.

*L. yeringae* Chapman.

*Loxonema* aff. *sinuosa* Sowerby.

*Nucleospira australis* McCoy.

*Nuculites* sp.

*Orthis* spp.

*Palaconeilo* sp.

*Pentamerus* sp.

*Rhipidomella* sp.

*Rhynchotreta* sp.

*Schizophoria* sp.

*Spirifer lilydalensis* Chapman.

*Spirifer* sp.

*Stropheodonta*, sp. nov. (?)

*Strophonella euglyphoides* Chapman.

*Strophonella*, sp. nov. (?)



I suggest that this locality be called "Hull Road, Mooroolbark".

(3) At Croydon on the Ipswich Road on the rise a little east of Dorset Road, fossils were found in brownish shales in the gutter on the north side of the road, viz.:

*Odontopleura rattei* Eth. and Mitch.

*Orthis* sp.

*Keilorites* sp.

(4) The furthest south Yeringian locality on the strike of the Lilydale beds so far described is that at Kilsyth (2). However, a new locality was discovered recently by Dr. I. Cookson and the author at the corner of Wellington Road and Stud Road, four miles north of Dandenong. Dark, reddish shales outcrop in a cutting on the north-east corner of the crossing, and from these a number of not too well preserved fossils were collected. They include:

*Chonetes bipartita* Chapman.

*Dalmanella elegantula* (Dalman).

Both of these forms are characteristic of the Yeringian series. I suggest that this locality be known as "Rowville", the name of the place as shown on the Military Map.

### **Yeringian Fossil Localities.**

Not a little confusion concerning Yeringian fossil localities has resulted from the fact that the actual sites have not been recorded on a map. In order to overcome this disability a map (fig 1.) accompanies this paper and the sites are numbered according to the list given below. Further, the use of more than one place-name for the same locality has often proved misleading. To overcome this further difficulty the accompanying notes have been compiled:

1. "Mooroolbark Road", "Kinsella's Gate", and "Hull Road" all refer to the red shales west of Cave Hill, outcropping in a road cutting 14 chains from the Melbourne-Lilydale highway. The road proceeds south from this highway at a point half a mile west of the township of Lilydale, and goes to Mooroolbark and thence to Croydon. The correct name for the road is Hull Road and I therefore propose that "Hull Road, Lilydale" be accepted exclusively as the locality name.

2. "Wilson's", as Cresswell has explained (5), is "On the old Melbourne Road, near the top of the hill, about half a mile above Lilydale." The fossils were collected "in the stuff thrown out of a sinking for a tank at Mr. Wilson's." This locality does not now exist, but on the same piece of road, called Albert Hill

Road by the residents, similar fossils have been collected from small outcrops and excavations. This locality and (1) have also been referred to simply as "Lilydale mudstone".

3. "North of Lilydale", "Hughes' Quarry" and "Yering" refer to the same place—a quarry at the summit of a low hill situated near the middle of the block of land bounded by the northern end of Edward Road, and the road which runs east to Coldstream, and Victoria Road. This section appears under the name of "James Shanley" on the Parish Plan of Yering. It has been said that "Hughes' Quarry" is the same as "Ruddock's Quarry" but this is not so because:

- (a) The fossils so recorded are in a different matrix from the Ruddock's Quarry fossils.
- (b) The following directions given by Cresswell (5) cannot be made to fit the Ruddock's Quarry locality—"About three miles to the north of the last mentioned point (Wilson's), and about fifteen chains to the west of the road that leads past the cemetery (N. and S. road) at an old quarry, known as Hughes' Quarry."

The road that leads past the cemetery is Victoria Road. I suggest that this locality be referred to exclusively by the original name of "Hughes' Quarry".

4. "Section XII. Parish of Yering", "Yering near Coldstream", "West of Yering Railway Station", "West of Coldstream Railway Station", "Yarra Flats, Yering", and "Mic. Black's Quarry, Coldstream" apparently all refer to the same locality, viz. an old quarry in a cutting (marked on the Military Map) on the road which proceeds east from "Devon Park" to Coldstream. The road forms the southern boundary of Section XII. of the Parish of Yering. The quarry is west of the Olinda Creek, at the edge of the river flats. The Geological Survey collected fossils from this place many years ago and labelled them "Sect. XII. Par. of Yering". The late Mr. Geo. Sweet collected a good deal of material from this locality, and the specimens are now housed in the National Museum. All the locality names mentioned, except the last, are hopelessly inadequate for present purposes. The last is liable to confusion with Mr. W. Black's quarry on the edge of the Toscanite on the other side of Coldstream. Until recently, when purchased by Mr. M. Black, the piece of ground in question belonged to the property called "Flowerfield" (see Military Map). I suggest that the locality be called "'Flowerfield' Quarry".

5. Fossiliferous strata outcrop at the southern end of the cutting at the northern end of which "Flowerfield" Quarry is situated. I suggest that this locality be called "'Flowerfield' Cutting".

6. "Cave Hill" limestone quarry.

7. "Melbourne Hill, Lilydale". This locality is a cutting on the main Melbourne-Lilydale road immediately west of the latter township. It is under the edge of the Older Basalt residual on the hill locally called "The Melbourne Hill". The beds outcrop beside the entrance to a quarry in the basalt and downhill for some distance. The strata comprise yellow and brownish shales.

8. "Cave Hill South" is the locality name suggested for the outcrop of limestone on the strike of the Cave Hill beds in the railway cutting a quarter of a mile south of Cave Hill (14). It is situated on the west side of the line 22 miles 11 chains from Melbourne.

9. "Mitchell's Paddock" is in the large paddock owned by the Mitchell Estate, bounded on its western and northern limits by Hull Road and the Melbourne-Lilydale highway respectively. At this point there is an outcrop of highly fossiliferous grey shales extending on and off for a chain in the banks of a rivulet which runs only in the winter. The outcrop may be located by following the fence beside the highway for 10 chains 89 links from Hull Road to a corner post then proceeding  $4\frac{1}{4}$  chains south.

10. "Albert Hill Road North" is practically at the northern limit of that road on the corner of an unnamed street on the west side of the road. Numerous fossils were collected from grey shales thrown up from a telegraph pole excavation.

11. "Albert Hill Road" is a locality about the middle of the road at the corner of another unnamed street south of that mentioned in (10). A trench dug on the west side of the road revealed highly fossiliferous grey shales. Fossils were also collected from the gutter on the east side of the road.

12. "Hull Road Railway Bridge". This locality is described in section IIb (1) of this paper.

13. "Hull Road, Mooroolbark". Described in section IIIb (2).

14. "Ipswich Road, Croydon". See section IIIb (3).

15. "Rowville". See section IIIb (4).

16. "Manchester Road". See section II. (2).

17. "Black Springs". See section II. (1).

18. "West of Black Springs". See section II. (3).

19. "Yarra Road". See section II.

20. "Ruddock's Quarry", North-west of Lilydale, is on the west side of Edward Road a little north of where it is joined by the road which proceeds west from the Lilydale cemetery. It is a disused quarry on the side of a hill a short distance from the road.

21. "Ruddock's Corner" is the name given the corner of Edward Road and the road which runs west from the Lilydale cemetery. The locality is near Ruddock's Quarry, and similar grey shales outcrop. Fossils were collected from rock dug out in the re-forming of the road and in the sinking of a hole for a telegraph pole.

22. "Edward Road Hill". See section IIIA (1).

23. "West of Lilydale Cemetery". In a cutting on the road which runs west from the Lilydale cemetery, about 10 chains from Victoria Road, brown sandstones outcrop which contain fairly numerous fossils.

24. "Victoria Road Cutting" is a cutting in Victoria Road immediately north of the cemetery. At this point brown to grey shales outcrop.

25. "'Devon Park' West". See section IIIA (2).

26. "'Devon Park' North". See section IIIA (3).

27. "Yering Gorge". See section IIIA (4).

28. "Coldstream Railway Cutting". In the long cutting just south of the Coldstream railway station at a point approximately 25 miles 51 chains from Melbourne, thinly-bedded shales outcrop containing *Styliolina*. A few brachiopods have been found in the surrounding strata.

29. "Kilsyth" is a locality recorded by Chapman (2). His description of it is "Kilsyth, about 2 miles from Croydon, on the road between the railway station and Mt. Dandenong, at a depth of about five feet from the surface." The fossils came from an excavation at the corner of Ipswich and Liverpool Roads.

NOTE.—The Military Maps referred to are the 1935 editions of Ringwood and Yan Yean.

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